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## ABSTRACT

This paper derives statements of the Heckscher-Ohlin Theorem which remain valid in the presence of market power. Following Helpman (1984a), the paper explores restrictions on permissible trade patterns that are implied by the post-trade equilibrium conditions of Heckscher-Ohlin theory. Restrictions on the patterns of commodity trade are derived to complement Helpman's factor content version of the competitive Heckscher-Ohlin theory, and the introduction of factor market power is shown to leave the validity of these restrictions unaffected. Restrictions on the pattern of Heckscher-Ohlin trade in the presence of product market power are also derived, and conditions are stated under which Helpman's competitive factor content restrictions continue to hold.

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## I. Introduction

Efforts to generalize the predictions of the Heckscher-Ohlin (HO) model of international trade have received a great deal of attention in recent years. A generalization of the model to a world of many goods, factors, and countries, in which factor prices are not necessarily equalized or preferences identical and homothetic can be found in Deardorff (1982). These predictions take the form of correlations among autarky factor prices, factor intensities, and multilateral trade in goods and, like the standard HO predictions, can be stated in either a commodity or a factor content version. Such results are important in that they demonstrate the implications of what is perhaps the fundamental assumption of HO theory--the international availability of technology--without many of the additional assumptions that have made the empirical relevance of the standard model suspect.

One assumption that is needed for Deardorff's results is that of perfectly competitive markets. Especially in light of the growing interest in the causes and implications of international trade in the presence of various forms of non-competitive markets, a generalization of Deardorff's results to a world of non-competitive markets would be useful. Unfortunately, such a generalization seems unlikely, at least until general gains-from-trade results in the presence of market power become available. This is because, as emphasized by Deardorff (p. 688), the derivation of his results rely heavily on the existence of gains from trade. Since a general gains-from-trade theorem in the presence of market power is not available, it is not clear how or even if

Deardorff's results can be generalized once the assumption of perfectly competitive markets is dropped.

While Deardorff's results provide general statements of the predictive power of autarky factor prices for the pattern of trade, Helpman (1984a) has derived restrictions on permissible trade patterns that are implied by the post-trade equilibrium conditions of HO theory. The only assumptions required for his results, which relate bilateral post-trade factor price differentials to the factor content of bilateral trade, are that technologies are linearly homogeneous and available internationally, and that markets are competitive.[1/] This paper adopts Helpman's focus on the post-trade equilibrium conditions implied by the HO theory and explores the extent to which the implications of the fundamental technological assumptions of the HO model can be uncoupled from the assumption of competitive markets.[2/] In particular, it will be shown that the HO restriction derived by Helpman - that one country will export to another the services of its relatively inexpensive factors - remains valid in the presence of various forms of factor market power, and will be invalidated by the existence of product market power only if the greatest relative exercise of domestic product market power tends to coincide with each nation's import-competing sectors.

At a theoretical level, the resulting characterization of trade patterns in a HO world with non-competitive markets ought to be of interest, since it provides a general statement of the way in which the international distribution of market power can influence the pattern of trade. From the standpoint of testing the empirical relevance of the HO

model's assumptions, these restrictions are of interest as well, since they represent testable implications of the technological assumptions of the theory in combination with various characterizations of the degree of market competitiveness.[3/]

Helpman's results are extended in two directions. First, restrictions on the pattern of commodity trade are derived to complement Helpman's factor content version of the competitive HO theory, and the introduction of factor market power is shown to leave the validity of these restrictions unaffected. This result is contained in section II. Next, the introduction of imperfectly competitive product markets leads to a simple and intuitive generalization of Helpman's conditions to a world with product market power. Restrictions on the pattern of product market power which leave Helpman's conditions unaltered are also considered. This is the subject of section III. Finally, section IV provides a concluding discussion and a brief comment on the implications of scale economies for the results of this paper.

## II. Non-Competitive Factor Markets

While Helpman relies on properties of the aggregate GDP function to derive his factor content results, restrictions on the commodity composition of trade are derived more transparently following the nonparametric approach of Varian (1984). However, intuition in a two-factor two-country world can be provided by the Lerner-Pearce diagram familiar from Heckscher-Ohlin theory. The diagram is depicted in Figure 1. Unit isocost lines summarize the combinations of capital and labor

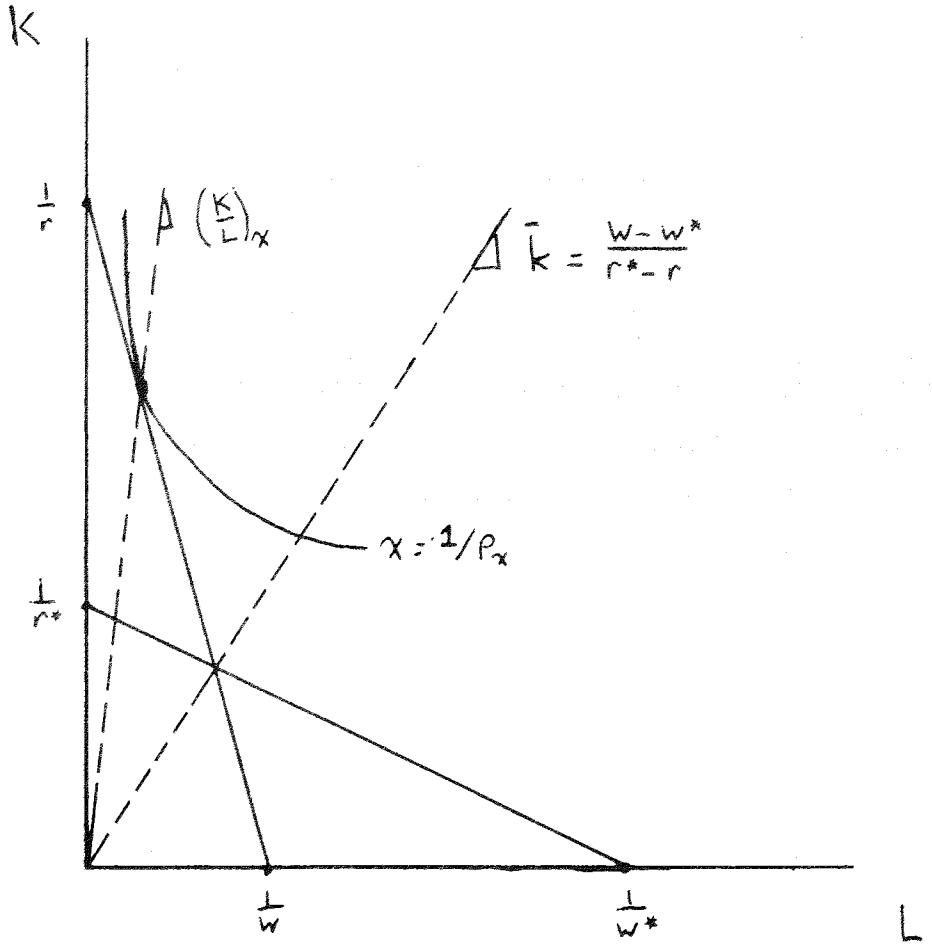
K
$\frac{1}{r}$
$\Delta \left(\frac{K}{L}\right)_x$
$\Delta \bar{k} = \frac{w - w^*}{r^* - r}$
$\chi = 1/\rho_x$
$\frac{1}{r^*}$
$\frac{1}{w}$
$\frac{1}{w^*}$
L

Figure 1

that can be hired for one dollar at factor prices $(w,r)$ and $(w^*,r^*)$ in the home and foreign country, respectively. The unit value isoquant labeled $x = 1/P_x$ gives the combinations of capital and labor sufficient to produce one dollar's worth of $x$ at price $P_x$. The ray from the origin through the point of intersection of the two unit isocost lines has slope $\bar{k}=(w - w^*)/(r^* - r)$. The slope of this ray is significant because, under perfect competition, any good produced in equilibrium in the home country must employ capital and labor in a ratio greater than $\bar{k}$, while any good produced in equilibrium abroad must employ capital and labor in a ratio lower than $\bar{k}$.

Thus, if good $x$ is exported from the home to the foreign country, it must be produced domestically and, as depicted by the unit value isoquant for $x$ in Figure 1, the ratio of capital to labor employed in the domestic production of $x$ must satisfy $K_x/L_x \geq (w - w^*)/(r^* - r)$, or $[(w^* r^*) - (w r)]\begin{bmatrix} L_x \\ K_x \end{bmatrix} \geq 0$.

Proposition I below provides a straightforward generalization of this restriction to $M$ factors and sector-specific factor prices.

In particular, consider any commodity $n$ exported from country $j$ to country $i$. If the technology in this sector is linearly homogeneous and firms minimize cost taking factor prices parametrically, then unit costs of production for good $n$ in country $j$ will be given by $w_n^j a_n^j$ where $w_n^j$ is a $(1 \times M)$ vector of post-trade factor prices in country $j$'s sector $n$, and $a_n^j$ is a $(M \times 1)$ vector of cost-minimizing unit factor requirements used in the production of $n$ in

country j.[4/] Note that the assumption of parametric factor prices rules out monopsony but is consistent with an economy-wide minimum wage (as in Brecher, 1974) and with factor market imperfections which lead to intersectoral factor price differentials (as, for example, in Magee, 1971).

Commodity n is by assumption exported from j to i, so that if producers are perfectly competitive, and if subsidies to the export of good n from j do not exceed transport costs and tariffs on imports of n into i, then the unit cost of producing n can be no less in i than in j. That is,

$$w_n^i a_n^i \geq w_n^j a_n^j \tag{1}$$

where $w_n^i$ and $a_n^i$ are, except for the country superscript, defined analogously to $w_n^j$ and $a_n^j$. Condition (1) must hold whether or not n is actually produced in country i. Finally, if technology in sector n is internationally available, then $a_n^j$ represents a feasible production technique in country i, and cost minimization implies

$$w_n^i a_n^j \geq w_n^i a_n^i \tag{2}$$

Combining (1) and (2), defining $T_n^{ij}$ as gross exports of commodity n from j to i, and making a symmetric argument with respect to exports from i to j, $T_n^{ji}$, yields

Proposition I: If perfectly competitive producers in sector n with no

monopsony power cost minimize subject to a linearly homogeneous production technology common to both countries i and j, then, provided subsidies are not so large as to outweigh transportation costs and import tariffs, the commodity pattern of bilateral trade must satisfy

$$[w_n^i - w_n^j]a_n^j \geq 0 \quad \text{for all} \quad n \quad \text{such that} \quad T_n^{ij} > 0$$

$$[w_n^j - w_n^i]a_n^i \geq 0 \quad \text{for all} \quad n \quad \text{such that} \quad T_n^{ji} > 0 \qquad (3)$$

Condition (3) provides restrictions on the pattern of bilateral commodity trade that must be satisfied by post-trade observations consistent with the general HO theory embodied in the assumptions of Proposition I. The condition says simply that the bundle of factors embodied in a unit of any good produced for export must be no more expensive to purchase in the exporting country in the post-trade equilibrium than it would be in the importing country. An alternative interpretation of Proposition I can be obtained by transforming (3) into a relationship between percentage bilateral factor price differentials and factor intensities. Define $\theta_n^j$ as a $(M \times 1)$ vector of factor intensities in country j's sector n with $m^{th}$ element given by

$$\theta_{nm}^j = \frac{w_{nm}^j a_{nm}^j}{\sum_m w_{nm}^j a_{nm}^j}$$

and define $\omega_n^{ij}$ as a $(1 \times M)$ vector of percentage bilateral factor price differentials in sector n with $m^{th}$ element given by

$$\omega_{nm}^{ij} = \frac{w_{nm}^{i} - w_{nm}^{j}}{w_{nm}^{j}} .$$

Then condition (3) can be rewritten as

$$\omega_n^{ij}\theta_n^j \geq 0 \quad \text{for all} \quad n \quad \text{such that} \quad T_n^{ij} > 0$$

$$\omega_n^{ji}\theta_n^i \geq 0 \quad \text{for all} \quad n \quad \text{such that} \quad T_n^{ji} > 0 \qquad (4)$$

where $\omega_n^{ji}$ and $\theta_n^i$ are defined analogously to $\omega_n^{ij}$ and $\theta_n^j$. The interpretation associated with (4) is that every export good is, in an average sense, intensive in factors that are relatively inexpensive in the exporting country in the post-trade equilibrium. This provides a generalization of the results of Jones (1956-57) and Bhagwati (1972) derived in a competitive two-factor world: that every good exported by the capital-abundant country must have a greater capital/labor ratio than every good exported by the labor-abundant country.

Helpman's factor content version of these restrictions can be derived immediately from (3) by assuming the absence of intersectoral factor price differentials. Dropping the industry subscripts on the factor price vectors, multiplying the two parts of (3) by the scalars $T_n^{ij}$ and $T_n^{ji}$, respectively, and summing over all $n$ yields Helpman's condition

$$[w^i - w^j]f^{ij} \geq 0 \qquad (5)$$

where $f^{ij}$, the $(1 \times M)$ vector of the factor content of net exports

from $j$ to $i$, is calculated on a country-of-origin basis and is defined as

$$f^{ij} = \sum_n [T_n^{ij} a_n^j - T_n^{ji} a_n^i]$$

Hence, under the assumption of competitive product markets, and ruling out monopsony and intersectoral factor price differentials, conditions (3) and (5) provide commodity and factor content versions of a very general HO theory. And in the presence of factor market imperfections which give rise to intersectoral factor price differentials, condition (3) provides valid HO restrictions on the commodity pattern of international trade.

## III. Non-Competitive Product Markets

Melvin and Warne (1973) introduced monopoly into the 2x2 HO model symmetrically, so that the equilibrium markup of price above cost in any sector was identical in the two countries, and showed that in this case the standard HO trade patterns continue to emerge from the model. However, relaxation of this symmetry property can lead to a reversal of the pattern of trade from that expected under competitive HO theory, as noted for example in Helpman (1984b). International differences in the degree of product market competitiveness can also invalidate condition (3) of Proposition I. That is, define the markup of producer prices above marginal cost--the Lerner index of market power--for good $n$ produced in country $j$ and sold in country $i$, $m_n^{ij}$, as

$$m_n^{ij} = \frac{p_n^{ij} - w_n^j a_n^j}{p_n^{ij}}$$

where $p_n^{ij}$ is the price received by producers in country $j$ if good $n$ is sold in country $i$. Since this markup may differ depending on the location of the producer and the market being served, define $m_n^{ii}$, $m_n^{ji}$, and $m_n^{jj}$ analogously to $m_n^{ij}$.

Now suppose that, in the post-trade equilibrium, country $i$ is observed to be importing good $n$ from country $j$ and that $[w_n^i - w_n^j]\, a_n^j < 0$ in violation of (3). However, suppose it is also observed that $m_n^{ii} > m_n^{ij}$. In this case one cannot rule out the possibility that technologies are indeed identical but that the relatively high markup of $i$'s producers for the sale of good $n$ in the domestic market has induced imports of $n$ from $j$ to $i$ that would not be profitable if producers in country $i$ priced competitively. This suggests the modification of the conditions of Proposition I to include a bilateral markup comparison in the importing country's market.

A more precise intuition can be provided by the two-factor Lerner-Pearce diagram of Figure 2. Suppose that good $x$ is observed to be exported from the foreign to the home country, but that its capital intensity in the foreign production process $K_x^*/L_x^*$ is greater than $(w - w^*)/(r^* - r)$. Could this be consistent with equilibrium behavior given identical technologies at home and abroad? Not with perfectly competitive goods markets, since positive profits would be earned by domestic producers operating at capital intensity $K_x/L_x$. In fact,

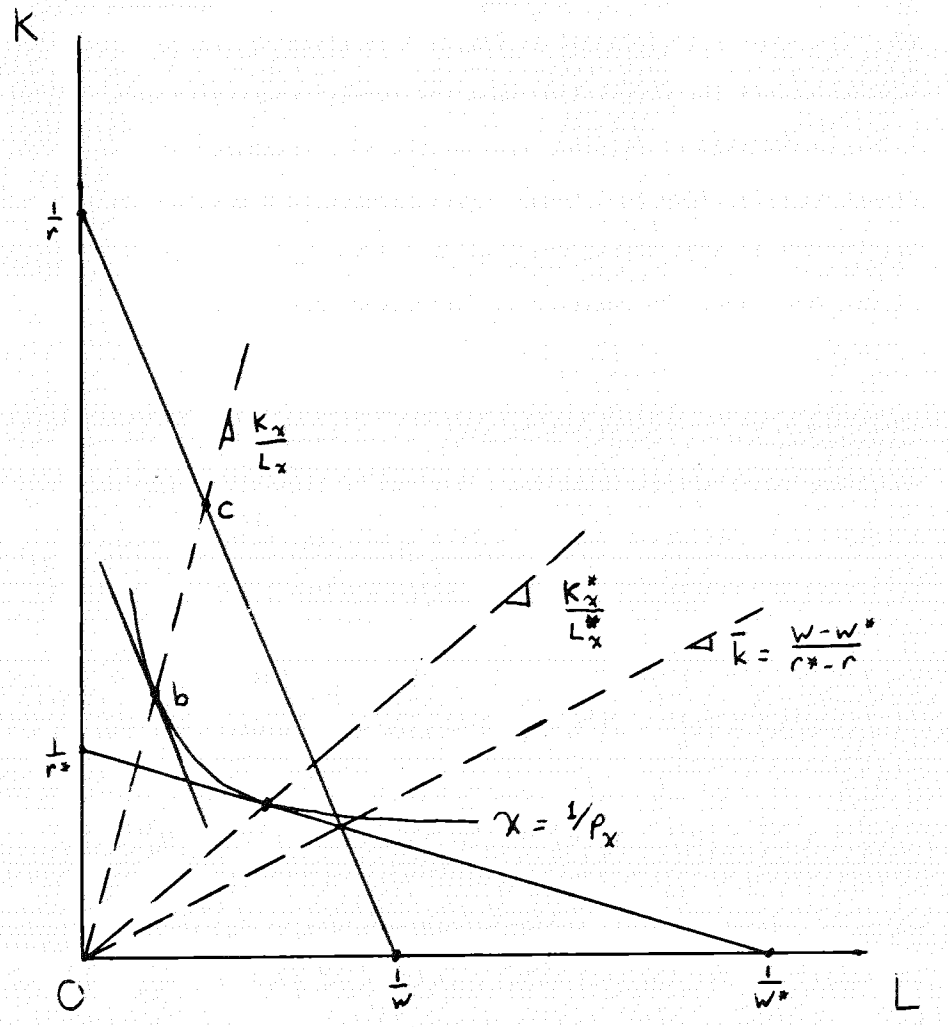
K
$\frac{1}{r}$
$\frac{K_x}{L_x}$
c
b
$\frac{K_x^*}{L_x^*}$
$\bar{k} = \frac{w - w^*}{r^* - r}$
$\frac{1}{r^*}$
$\chi = 1/\rho_\chi$
C
$\frac{1}{w}$
$\frac{1}{w^*}$
L

Figure 2

given the assumptions of identical technologies, cost-minimization, and perfect competition in the foreign product market, the domestic markup of price above cost implicit in Figure 2 is given by bc/0c. Hence, whether or not the observation that the foreign country exports x is to be interpreted as evidence against the HO presumption of internationally identical technologies depends in a precise way upon whether and to what degree the equilibrium markup in sector x differs across countries. Proposition II formalizes this intuition.

Proposition II: If producers of good n in countries i and j lack monopsony power and minimize costs subject to linearly homogeneous production technologies common to both countries, then, provided subsidies are not so large as to outweigh transport costs and import tariffs, the following conditions must hold:

$$[w_n^i - w_n^j]v_n^j + [m_n^{ii} - m_n^{ij}] \geq 0 \quad \text{for all} \quad n \quad \text{such that} \quad T_n^{ij} > 0$$

$$[w_n^j - w_n^i]v_n^i + [m_n^{jj} - m_n^{ji}] \geq 0 \quad \text{for all} \quad n \quad \text{such that} \quad T_n^{ji} > 0 \qquad (6)$$

where $v_n^j$ is a (M x 1) vector of cost-minimizing factor requirements in country j for the unit value production of good n, $\frac{1}{p_n^{ij}}$, defined by

$$v_n^j = \frac{a_n^j}{p_n^{ij}} ,$$

and $v_n^i$ is defined analogously.

Proof: Since $p_n^{ii}$ and $p_n^{ij}$ are prices received for the sale of good $n$ in country $i$ by producers of $n$ in countries $i$ and $j$, respectively, the assumption on the relative sizes of transport costs, tariffs, and subsidies ensures that

$$p_n^{ii} - p_n^{ij} \geq 0 \tag{7}$$

Using the definition of $m_n^{ii}$, $p_n^{ii}$ can be rewritten in terms of $m_n^{ii}$ and unit costs of production and substituted into (7) to yield

$$w_n^i a_n^i - (1-m_n^{ii})p_n^{ij} \geq 0 \tag{8}$$

Cost minimization and the international availability of technology implies that $a_n^i$ can be replaced by $a_n^j$ without violating (8) to yield

$$w_n^i a_n^j - (1-m_n^{ii})p_n^{ij} \geq 0 \tag{9}$$

Using the definition of $m_n^{ij}$, $w_n^j a_n^j$ can be written as $(1-m_n^{ij})p_n^{ij}$, so that subtracting and adding $w_n^j a_n^j$ to (9) yields

$$[w_n^i a_n^j - w_n^j a_n^j] - [(1-m_n^{ii})p_n^{ij} - (1-m_n^{ij})p_n^{ij}] \geq 0 \tag{10}$$

Finally, dividing (10) through by $p_n^{ij}$, simplifying, and making a symmetric argument with respect to exports from $i$ to $j$, yields (6), which completes the proof.

Proposition II provides a simple generalization of the commodity statement of the HO theory contained in Proposition I by allowing for non-competitive product markets--in addition to imperfect factor markets--as captured by bilateral post-trade equilibrium markup differentials. The condition illustrates the precise way in which the pattern of product market power across countries, as captured by international variations in the Lerner index, can affect the pattern of commodity trade in a HO world. A sense of how factor intensities and product market power combine to determine the pattern of commodity trade can be gained by defining a second measure of factor intensity, $\phi_n^{ij}$, a $(M \times 1)$ vector with $m^{th}$ element given by

$$\phi_{nm}^{ij} = \frac{w_{nm}^{j} a_{nm}^{j}}{p_n^{ij}} .$$

With $\omega_n^{ij}$ and $\omega_n^{ji}$ defined as before, and with $\phi_n^{ji}$ defined analogously to $\phi_n^{ij}$, (6) can be rewritten as

$$\begin{aligned} &\omega_n^{ij}\phi_n^{ij} + [m_n^{ii} - m_n^{ij}] \geq 0 \quad \text{for all } n \text{ such that } T_n^{ij} > 0 \\ &\omega^{ji}\phi_n^{ji} + [m_n^{jj} - m_n^{ji}] \geq 0 \quad \text{for all } n \text{ such that } T_n^{ji} > 0 \end{aligned} \tag{11}$$

Condition (11) says that, controlling for bilateral differences in market power, every export good must, in an average sense, be intensive in those factors that are relatively inexpensive in the exporting country in the post-trade equilibrium. But the condition makes precise

the way in which bilateral differences in the exercise of market power can diminish the importance of factor intensities in determining the pattern of commodity trade. That is, with respect to the importing country's market for n, the greater is the markup of import-competing producers relative to producers abroad, the smaller will be the role played by factor intensities in determining the commodity pattern of trade.

Ruling out intersectoral factor price differentials leads to a generalization of Helpman's factor content statement in the presence of product market power. This is Proposition III.

Proposition III: If the assumptions of Proposition II hold and in addition, there are no intersectoral factor price differentials, then

$$[w^i - w^j]f^{ij} + [M^i - M^j]\tau^{ij} \geq 0 \qquad (12)$$

where $M^i$ is a (1 x N) vector with $n^{th}$ element $m_n^{ii}$ for n such that $T_n^{ij} > 0$ and $m_n^{ji}$ for n such that $T_n^{ji} > 0$, $M^j$ is a (1 x N) vector with $n^{th}$ element $m_n^{ij}$ for n such that $T_n^{ij} > 0$ and $m_n^{jj}$ for n such that $T_n^{ji} > 0$, and $\tau^{ij}$ is a (N x 1) vector with $n^{th}$ element $\tau_n^{ij}$ representing the value of net exports of n from j to i, valued at export prices, or

$$\tau_n^{ij} = p_n^{ij}T_n^{ij} - p_n^{ji}T_n^{ji}$$

Proof: The results follow immediately from Proposition II by dropping the $n$ subscripts on the factor price vectors, multiplying the two parts of (6) by $p_n^{ij}T_n^{ij}$ and $p_n^{ji}T_n^{ji}$, respectively, and summing over all $n$.

Proposition III implies that the existence of product market power will not invalidate Helpman's factor content version of the HO theory as contained in (5) as long as bilateral differences in product market power are non negatively related to sectoral export performance. This is the statement at the following Corollary.

Corollary: If the assumptions of Proposition III hold and, in addition, bilateral trade is balanced at export prices, then the existence of product market power will leave intact Helpman's factor content restrictions provided that bilateral differences in market power and bilateral export performance are non negatively correlated across sectors in the sense that

$$\text{Cor}[M^j - M^i, \tau^{ij}] \geq 0 \tag{13}$$

Proof: The result follows from Proposition III and the assumption of balanced bilateral trade at export prices, which ensures that the sign of the correlation between $[M^j - M^i]$ and $\tau^{ij}$ is the same as the sign of the corresponding inner product.

A simple example of a particular market structure that would satisfy the restrictions of (13) is provided by the Cournot-Nash

equilibrium of an m-firm oligopoly, with m/2 firms operating in each of the two countries of a two-country world. Suppose that firms in the oligopoly sector have incurred some sunk cost and produce at constant marginal cost, all other sectors in the two countries behaving competitively. In the absence of impediments to trade, the equilibrium (world) market share of each of the m firms will depend on its marginal costs. In particular, if at post-trade equilibrium factor prices the cost of production in the oligopoly sector differs in the two countries, the m/2 firms operating in the lower cost country will have relatively high markups, and will individually and as a group capture a larger share of the (world) market than the m/2 firms operating in the high cost country. If demand for the good is divided equally over the two countries, then the country with high-markup firms will be a net exporter of the good. With this the only non-competitive sector by assumption, condition (13) will be satisfied, and Helpman's factor content restrictions will remain valid.

Condition (13) is an equilibrium restriction on the interaction between the pattern and degree of product market power and the pattern of commodity trade which, if satisfied, will ensure that the existence of product market power does not invalidate the implications of the competitive HO theory as derived by Helpman. While various market structures may satisfy (13) and thus leave in tact the implications of the competitive HO theory, whether (13) is in fact satisfied is largely an empirical question. As such, this corollary points to the importance of information on the empirical relationship between market power and

sectoral trade performance in attempting to gauge the degree to which the competitive HO theory will fall short in characterizing observed patterns of trade (or the factor content of trade). In that sense, condition (13) provides the theoretical basis for an empirical exploration of the importance of non-competitive trade theories in accounting for the empirical shortcomings of the competitive HO model.

## IV. Discussion

This paper has explored the possibility of developing general restrictions on the pattern of international trade implied by a model which assumes the existence of internationally available technologies and little else. In particular, restrictions implied by HO theory have been derived which remain valid in a world consisting of arbitrary numbers of goods, factors, and countries, characterized by the existence of market power in factor and product markets, trade impediments, unequal factor prices, and preferences which are neither identical nor homothetic.

The results of this paper provide clear statements of the way in which post-trade factor prices, factor intensities, and market power combine to characterize the pattern of trade. In particular, the traditional HO emphasis on factor intensities as a guide to the pattern of trade remains appropriate in the presence of factor market distortions, provided that post-trade equilibrium conditions are used to characterize HO trade patterns. However, the focus on factor intensities will be misguided in this context if the international distribution of relative

product market power is related inversely to export performance: that is, if the greatest relative exercise of domestic product market power tends to coincide with a nation's import-competing sectors.

Finally, it should be noted that the assumption of linearly homogeneous technologies maintained throughout this paper can be relaxed somewhat without invalidating any of the results. In particular, the above restrictions must be met by equilibrium trade patterns in the presence of increasing returns provided that the minimum efficient scale of operation in the exporting country's sector n is no larger than the amount of bilateral exports of good n.[5/] Thus what is required is that a single producer's scale economies in the exporting country would be exhausted if it alone were to produce the bilateral export bundle of good n. While this limits the degree of scale economies, it nevertheless allows a degree of increasing returns that could conceivably give rise to substantial degrees of product market power.

## Footnotes

1/ Though Helpman (1984a) points out that his conditions remain valid in the special case of symmetric differentiated product equilibria where the scale of operation of firms in any industry is the same across countries.

2/ While factor market imperfections may exist independently of scale economies in production, it is natural for a relaxation of the constant-returns-to-scale assumption to accompany the relaxation of perfectly competitive product markets. The assumption of linear homogeneity is maintained throughout the formal analysis, but section IV notes how scale economies that give rise to product market power can be introduced without invalidating any of the results.

3/ The need for such conditions has been emphasized by Krueger (1983, p. 80).

4/ Helpman assumes the absence of intermediate inputs into production, and the same assumption will be made throughout this paper. However, all the results of this paper can be shown to hold in a world with traded intermediate goods as long as there are no intermediate good tariffs or transport costs, and provided that the factor content of trade is measured on a direct basis, i.e., excluding the factor content of intermediate inputs. For a discussion of the role of intermediate goods, see Staiger (1986).

5/ In this case, the factor content of country j's exports of good n can be calculated as the quantity of exports multiplied by the average factor content of one unit of good n produced in country j. Similarly, industry markups can be interpreted as the markup of price above average cost, and would thus continue to represent unit economic profits. The conditions in this paper would then allow observed data to be checked for consistency with the equilibrium conditions of HO theory in the presence of such scale economies.

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